

Further Compressor Development to Reduce GHG Emissions for MAC System

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Presentation Outline

Reduction in GHG Emission from Mobile A/C Compressor

- ❖ Direct GHG Emission; Refrigerant Leakage Reduction

Target: 50% Compressor Leakage Reduction

- ❖ Indirect GHG Emission;

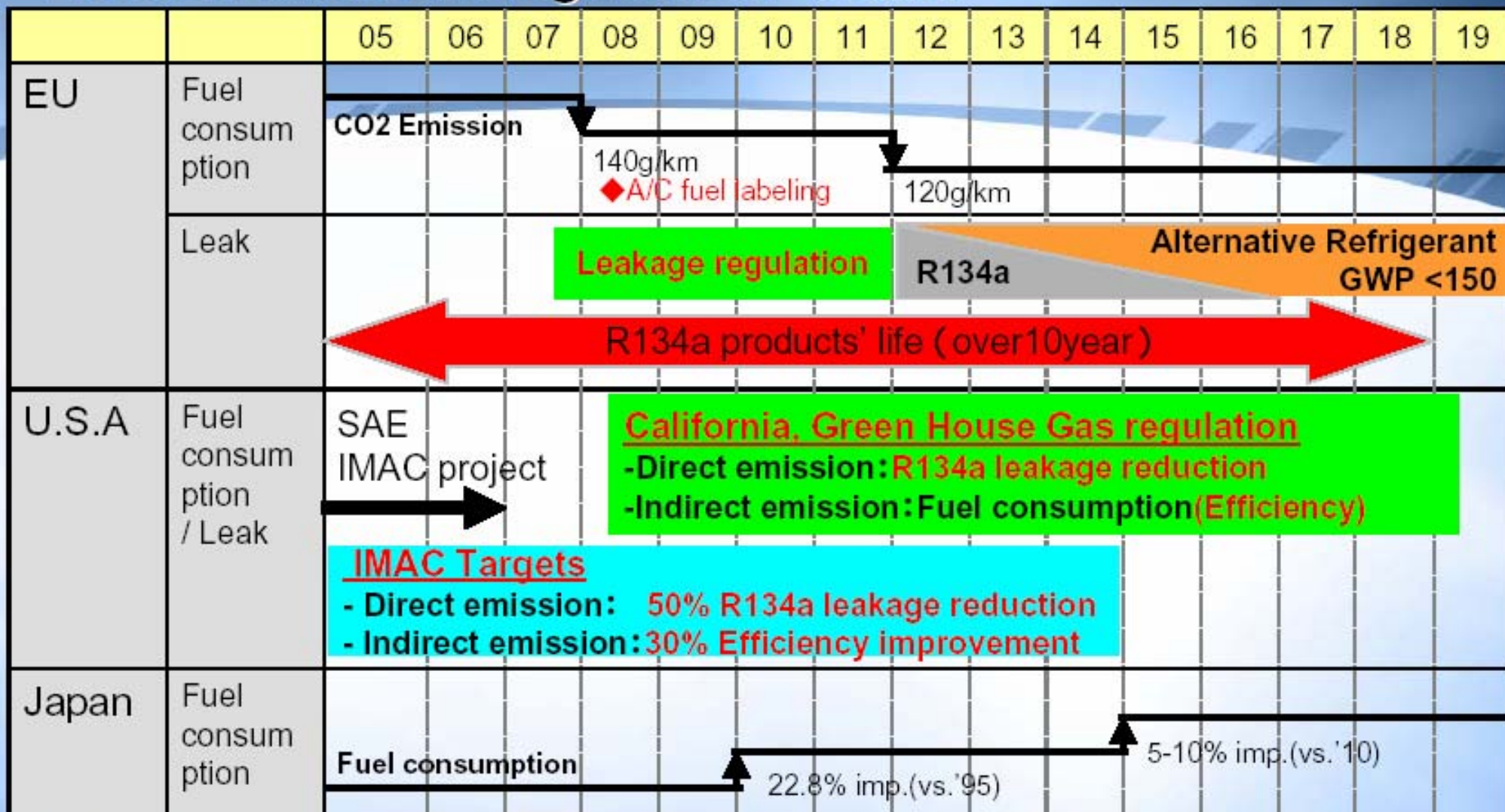
- **Compressor Efficiency Improvement**

Target: 30% Compressor COP Improvement

- **Efficiency Improvement thru Compressor Control Method**

Target: 50% Power Reduction During Acceleration

Environmental Regulation Trend



Greater Restrictions on GHG Emissions

Refrigerant Leakage Reduction
from Mobile A/C Compressor

Current Status / Tasks

Establishment of Leak Rate Measurement Method

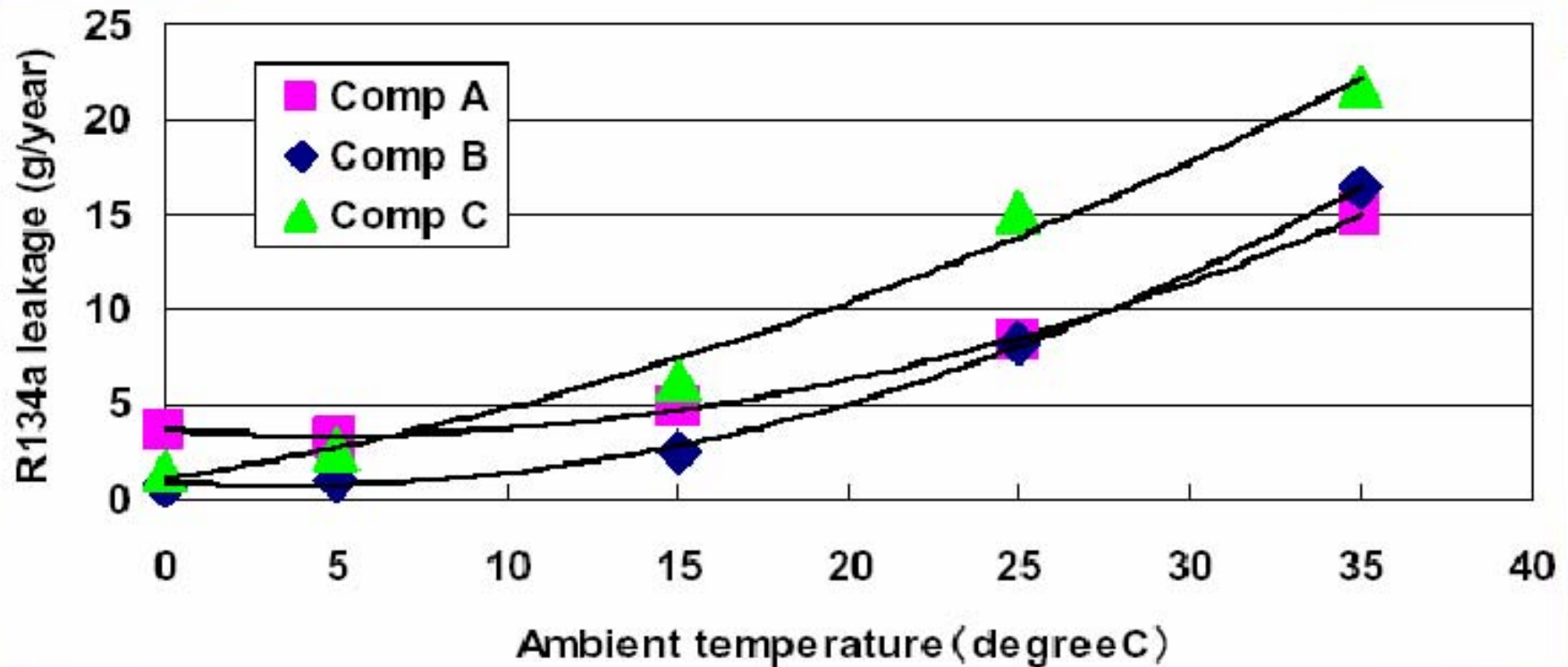
- ▶ Establish method for measuring actual leakage rate of both “Interstice” & “Permeation” leak from compressor.
- ▶ Develop new production equipment to meet EU refrigerant leakage regulation.

Verification of Leakage Rate & Identification of Leak Paths

- ▶ Measure actual leakage rate from whole compressor & shaft seal.
- ▶ Re-evaluate all sealing materials / re-design for leakage reduction.

Compressor Refrigerant Leakage

Total compressor leakage rate (interstices & permeation).
Static Conditions

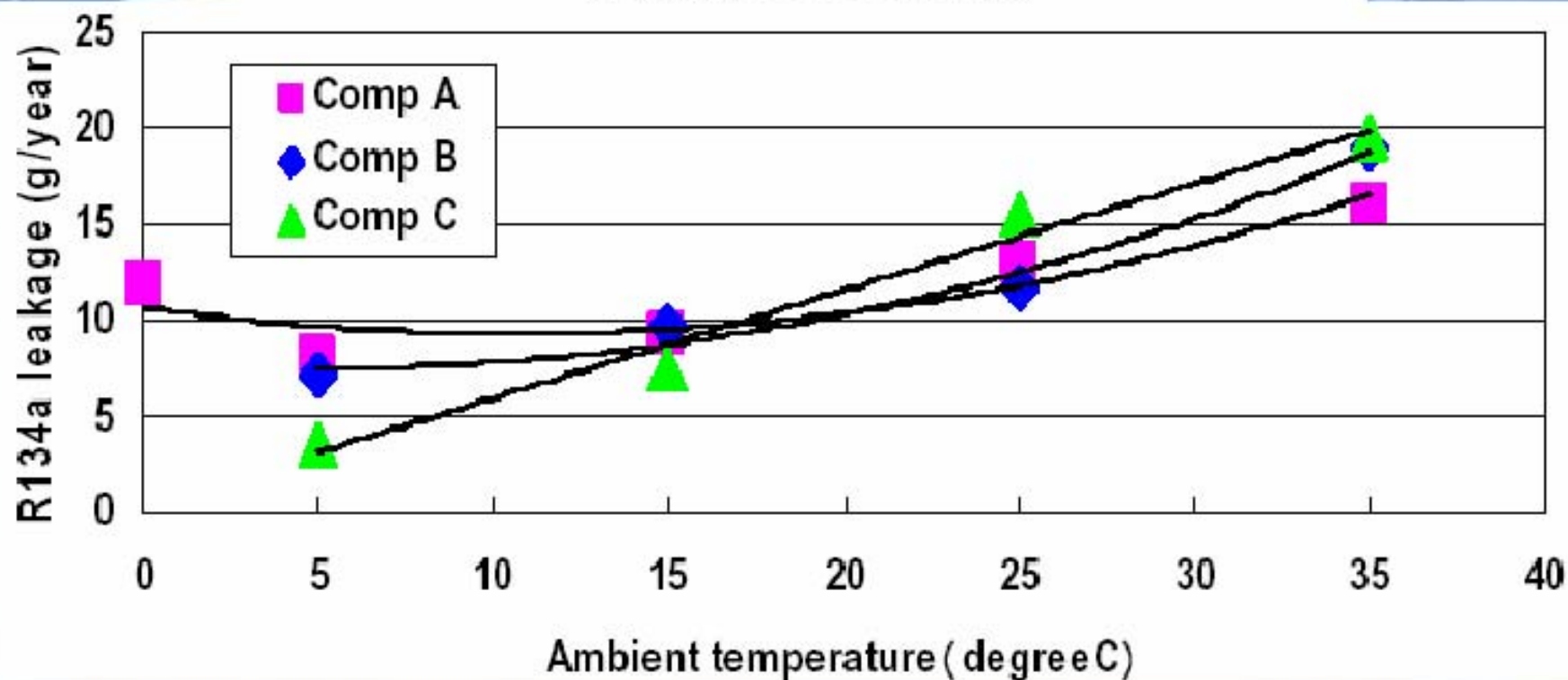


- The leakage rate increases with increase in the temperature.
- Relatively high leakage rate of Comp C at high temperature is suspected to be due to permeation through sealing O-ring.

Compressor Refrigerant Leakage

Total compressor leakage rate (interstices & permeation).

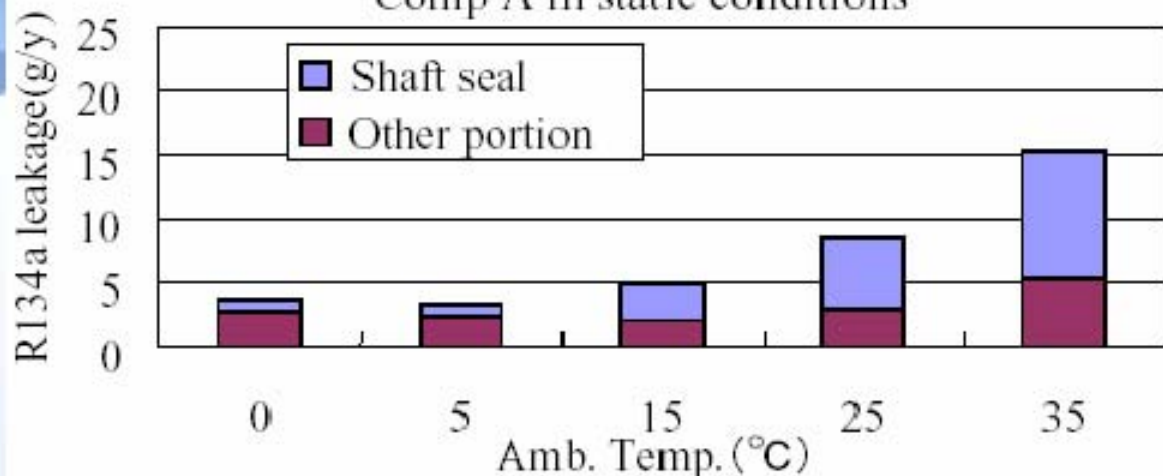
Dynamic Conditions



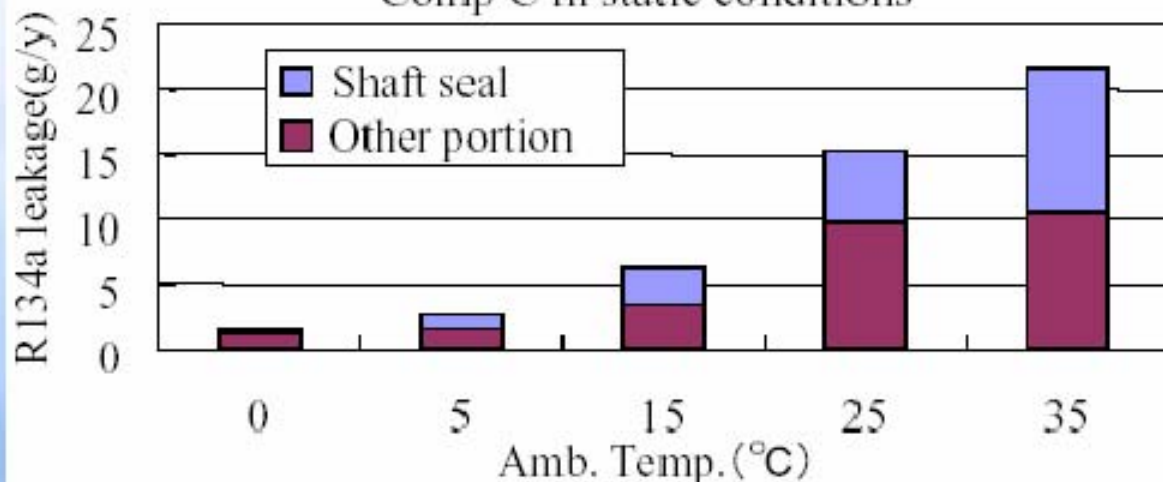
- Similar trend to static condition was observed.
- Clutch-less compressor (Comp A) has relatively high leakage rate at 0 degC as shaft rotation increases compressor temperature.

Refrigerant Leakage ; Defining Leak Path

Comp A in static conditions



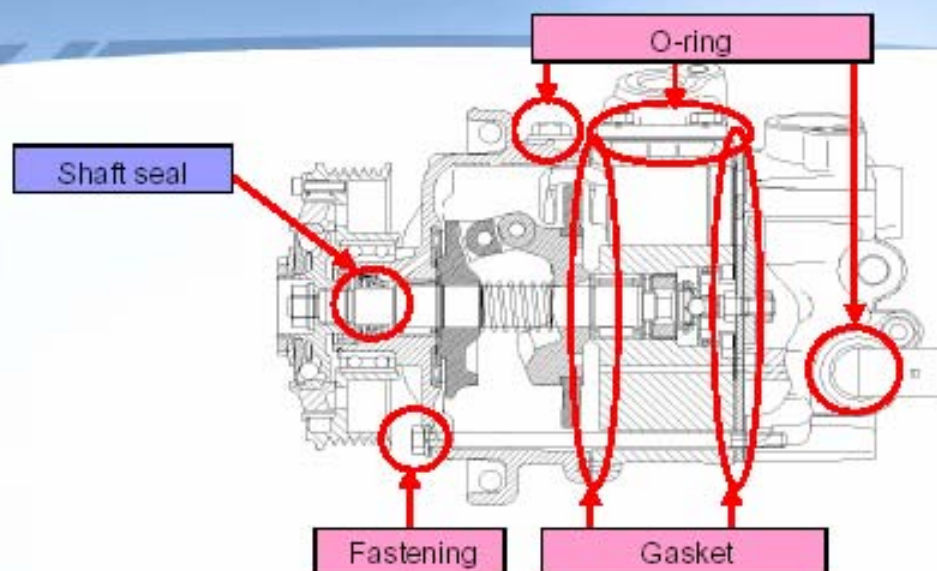
Comp C in static conditions



Leakage from Shaft Seal Accounts for ~ 50% of Compressor's Total Leakage.

Improvement of both shaft seal and other seal areas are crucial

Compressor Refrigerant Leakage



Aspects to be considered

Shaft seal

- Generation of hydrodynamic pressure on the lip ring of shaft seal
- Optimization of surface roughness
- Optimization of gasket design
- Optimization of the compression force at sealing parts

Other sealing section

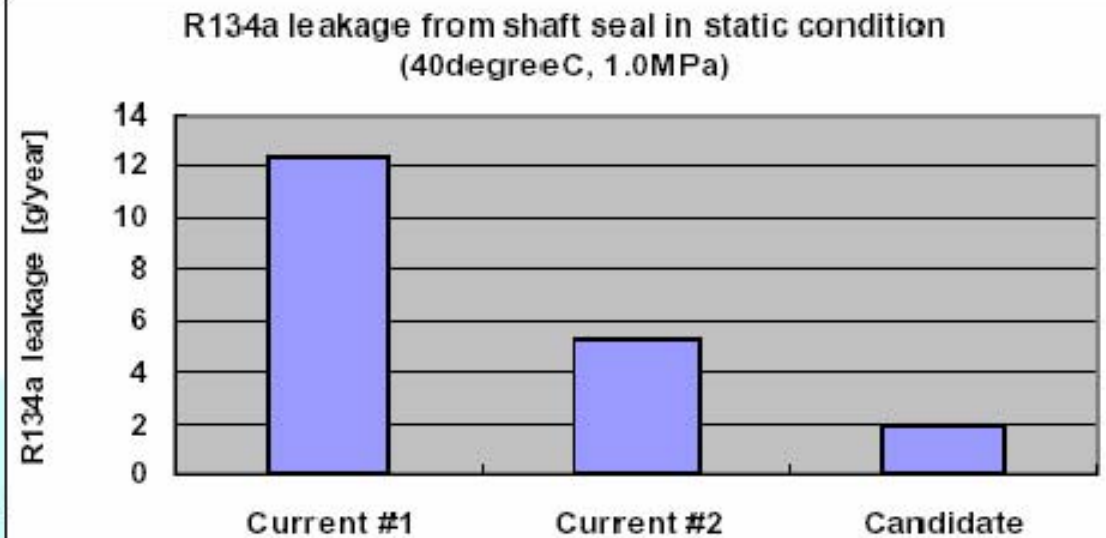
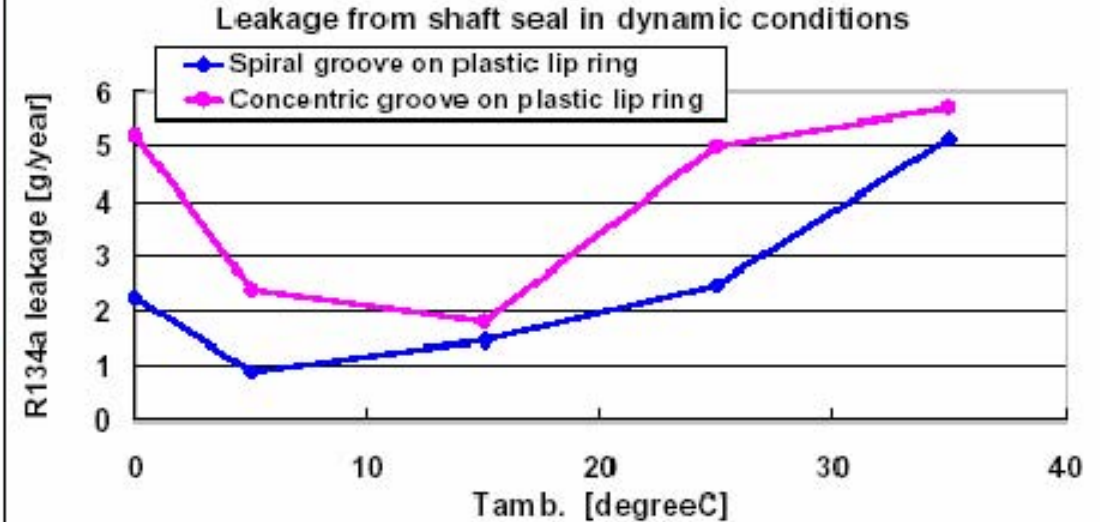
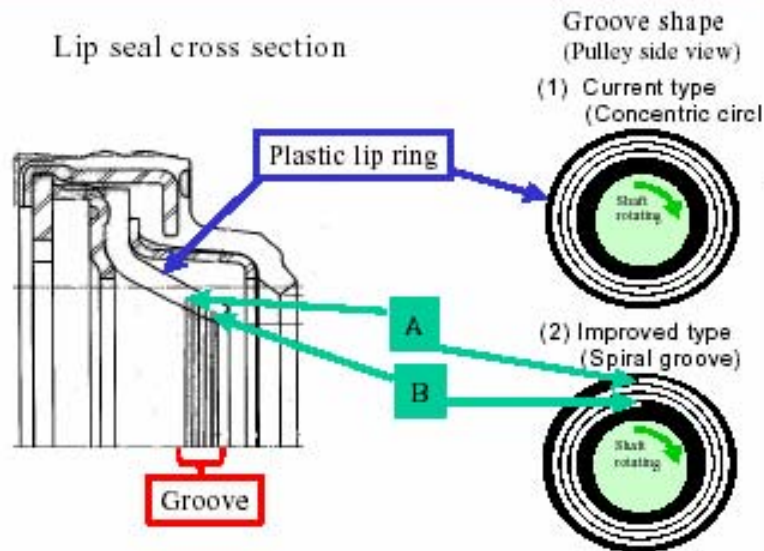
- Conversion to lower permeation material
- Increase in the permeation distance
- Decrease in the permeation area
- Reduction of temperature at the seal

Shaft Seal Improvement

Novel design of seal lip

Reduction of leakage by hydrodynamic force between the lip ring and the shaft.

(anticipated improv. : 10 - 25%)

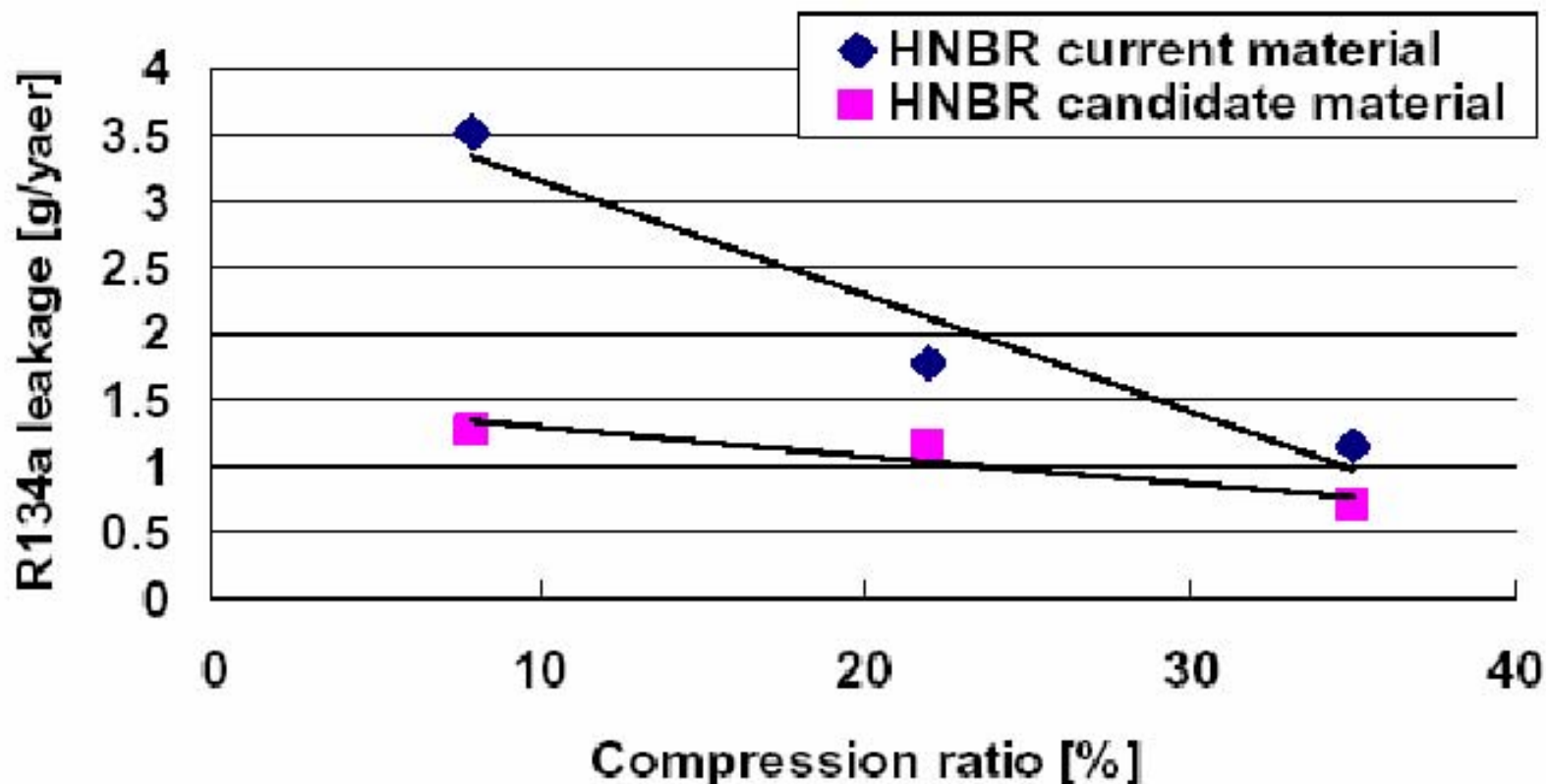


Novel material for seal lip

Decrease permeation leakage rate.
(anticipated improv. : 60 - 80%)

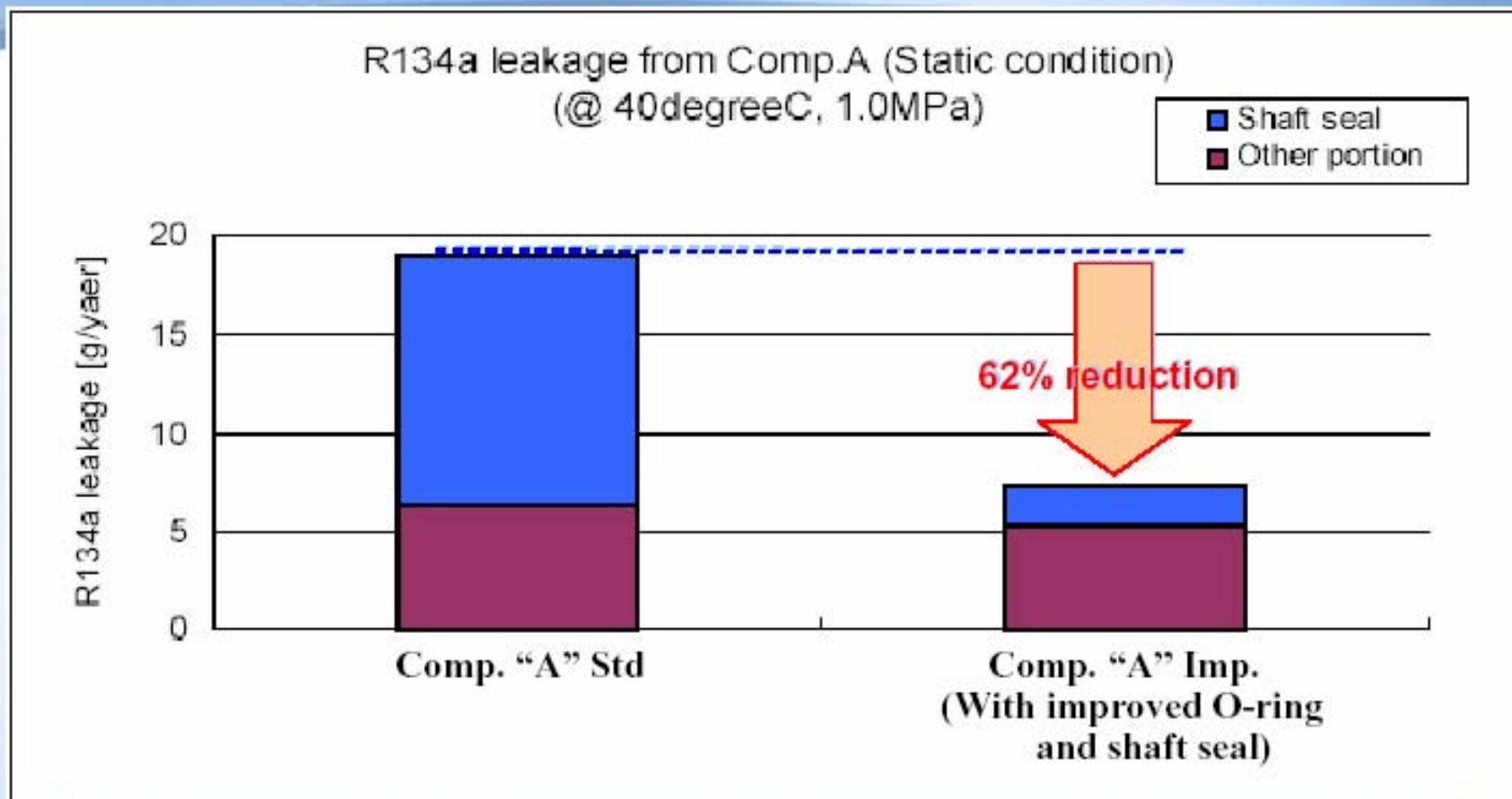
New O-ring Material

R134a leakage from O-ring seal
(I.D.35mm, d2.5mm, @ 25degreeC, 0.67MPa)



Anticipated leak reduction : 40 - 60%

Total Leakage Reduction



**62% leakage reduction by improving sealing parts.
(O-ring and shaft seal)**

Compressor Efficiency Improvement

SANDEN Compressor Line-up

